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## NOTES ON THE BREEDING SEASONS OF SOME ILLINOIS CARABID BEETLES

(Coleoptera)

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The investigations of Larsson (1939) and Lindroth (1949) have emphasized that in western Europe the Carabidae can be divided broadly into two groups according to their reproductive season: the "spring breeders" (Frühlingstiere) of Larsson or the "imaginal overwinterers" of Lindroth, and secondly, the "fall breeders" (Herbsttiere) or "larval overwinterers" of the two authors respectively. Further, it has been shown that the fall breeders tend to make up a higher proportion of the Carabid species occurring on the North Atlantic seaboard than those recurring in less oceanic regions of Europe. However, studies have not been made on mid-continental faunas. Studies on the breeding seasons of the carabid fauna of temperate North America, for which a trans-continental transect could be made, would be most informative.

The material used was collected on April 25 and May 16, 1953, during field excursions to Carlé Woods, Cook County, Illinois by the C2 Biology Class of Northwestern University under the direction of Professor Orlando Park.

Carlé Woods is an Oak-Sugar Maple Community which is the climatic climax in this region. My tentative identifications were carefully checked by Professor Park against material in his own reference collection; I am very grateful to him for this service. The names given are those of Leng (1920).

The beetles were brought back to the laboratory alive and dissected as soon as possible in a balanced saline solution of the following constitution:

Sodium chloride 9.0 gs. Potassium Chloride 0.2 gs.

Calcium chloride 0.2 gs. Distilled water to 1,000 ml.

which is a modification of Pringle's formula given in Roeder (1953). In females the states of the ovaries were noted, the eggs in the oviducts counted and the spermathecae removed to a slide for microscopic examination. In the males the states of the ac-

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cessory glands were noted and the testes and vasa deferentia removed to a slide for microscopic examination.

Carabid females possess a pair of polytrophic ovaries each discharging into a lateral oviduct which joins its fellow to form a medial vagina. In the polytrophic ovary the developing eggs are each surmounted by a ring of nurse cells which accompany the egg as it progresses along its ovariole. When the mature egg is discharged into a lateral oviduct the remnants of the nurse cell are left at the base of the ovariole and are visible as brown granules, the corpora lutea; they have no known endocrine activity. The intensity of the corpora lutea provides a rough guide to the number of eggs discharged from the ovariole. The spermatheca is an elongated sac lying, with its gland, mid-way along the dorsum of the vagina; its dissection is often difficult.

The males have typically a pair of testes each with a coiled vas deferens, although in some species the testis and its vas may be absent on one side. Each vas runs into the neck of an accessory gland, a sac which is filled with opaque white material when functional. Below these glands the lateral ducts join to form a medial ejaculatory duct. The sperm is discharged from the testis in packets, each packet consisting of a hyaline core to which the spermatozoa are attached by their heads. In many species this core elongates in the vas to form a ribbon, a twisted rope of these ribbons with sperm attached being transferred to the female at copulation.

#### CARABUS LIMBATUS Say

*Females:* 4/25/53. One specimen dissected. Ovaries contained developing eggs. Mature eggs present in the oviducts. Corpora lutea invisible. Spermatheca not examined. 5/16/53. One specimen dissected. Ovaries containing developing eggs. Mature eggs present in the oviducts. Corpora lutea faint. Spermatheca not examined.

*Males:* 4/25/53. One specimen dissected. Testes full of mature sperm packets. The vasa, which were divided into three regions, contained active spermatophores throughout their lengths.

This species is obviously a spring breeder and presumably a larval overwinterer. No information relevant to its life-history is given by Blatchley (1910).

#### EUFERONIA STYGICA (Say)

*Females:* 4/25/53. Three specimens dissected. In each the ovaries were small without developing eggs, and the corpora lutea

were intense. No satisfactory spermathecal preparations made.

5/16/53. Four specimens dissected. Each showed the same state as those dissected earlier. Two satisfactory spermathecal preparations were made; sperm ribbons were present but no sperm was seen attached to them.

*Males*: 5/16/53. One specimen dissected. The testes were full of spherical morulae; the vasa were empty and the accessory glands contained no opaque material.

This species presents a problem—have the females laid their eggs earlier in the current spring, or did they do so in the previous year and then over-winter although they had already reached sexual maturity? Blatchley gives no relevant information. In the first case the species will be a normal spring-breeder. In the second, it is probably an autumn-breeder overwintering mainly in the larval state but with a proportion of the mature adults overwintering after reproduction. This would parallel what occurs in *Calathus erratus* Sahlberg in Britain (Gilbert, 1954).

#### POECILUS LUCUBLANDUS Say

*Females*: 4/25/53. Two specimens dissected. Ovaries small without developing eggs and without corpora lutea. Presumably neither specimen had reached maturity. Spermathecae not examined.

*Males*: 4/25/53. Three specimens dissected. In all three the testes contained mature sperm packets basally and immature morulae apically. A few ribbons were present in the vasa. Accessory glands contained a little opaque material.

It is probable that this is a late spring breeder. Blatchley states that the species overwinters in the imaginal state which supports this contention.

#### DYSIDIUS MUTUS (Say)

*Females*: 4/25/53. Three specimens dissected. Each contained mature eggs in the oviduct. Corpora lutea faint or invisible. The spermatheca of one specimen was examined and found to contain sperm ribbons. 5/16/53. Three specimens dissected. Oviducts contained mature eggs. Copora lutea faint. All three specimens had sperm ribbons in the spermatheca.

*Males*: 4/24/53. Nine specimens dissected. In each the vasa contained ribbons bearing active sperm and the accessory glands were full of opaque material. The testes of seven were examined; they were full of mature sperm packets except in one specimen

in which there was, in addition, a small number of immature sperm packets. 5/16/53. Six specimens dissected. In each the vasa contained sperm bearing ribbons and the accessory glands were full of opaque material. The testes were examined in five specimens; a great reduction in the number of mature sperm packets was noted, the upper part of the testis tubes being empty in all cases (cf. 4/24/53).

It is impossible to delimit the egg-laying period on the present data. As mature eggs were found in the oviducts of both samples it is reasonable to assume that egg laying was in progress on both dates. The faintness of the corpora lutea shows that the bulk of the eggs had not then been discharged, and also that this was the first egg-laying season of these animals. Blatchley states that this species hibernates as an adult; this agrees with the evidence derived from dissection which is of spring-breeders overwintering as imagines prior to reproduction. Blatchley also states that the adults are found from April until December; it is very probable that those found at the end of summer and in the fall are newly emerged and derived from eggs layed in the previous spring. (Carabids typically have one generation per year, usually dying soon after reproduction.) Not all imaginal overwinterers have this fall emergence; some overwinter as adults in the pupal cell.

Examination of the testes showed that during the three week period, April 25–May 16, there was a marked reduction in the amount of sperm present. As there was no compensating increase in the sperm content of the vasa it is to be assumed that during this period there was a considerable amount of copulation. The date of onset of copulation cannot be given but obviously lies before April 25.

#### DICHAELUS POLITUS Dejean

One specimen dissected, a female, collected on May 16. Both ovaries contained developing eggs and mature eggs were present in the oviducts. The corpora lutea were well marked. Spermatozoa attached to sperm ribbons were found in the spermatheca.

This species obviously breeds in the spring and therefore probably overwinters as an adult. Blatchley gives no information on this point.

#### PLATYNUS SINUATUS (Dejean)

*Females:* 5/16/53. Two specimens dissected. In both, the ovaries were functional and mature eggs were present in the ovi-

ducts. The corpora lutea of one were faint but in the other were well marked. Both contained sperm ribbons in the spermatheca.

*Males:* 4/25/53. One specimen dissected. Testes full of mature packets. Many sperm ribbons in the vasa. Accessory glands full of opaque material.

This species is obviously a spring-breeder and therefore, probably an imaginal overwinterer.

Blatchley's dates, April 10–August 13, support this.

#### XESTONOTUS LUCUBRIS (Dejean)

One specimen dissected: this was a male collected on May 16. Only one testis was found. The testis contained only immature spherical sperm morulae. The vas was empty. No data recorded for the accessory glands.

From this specimen it is not possible to conjecture as to the breeding type of this species. Blatchley's dates for imagines, April 19–December 19, are not helpful.

#### AMPHASIA INTERSTITIALIS (Say)

One specimen dissected, a male collected on May 16. Only one testis and vas were present. Testis full of mature sperm packets. Vas contained sperm ribbons. Accessory glands full of opaque material.

This species is probably a spring-breeder and imaginal overwinterer. This contention is supported by Blatchley's datum that "A half dozen just emerged as imagoes were noted on November 28."

#### SPONGOPUS VERTICALIS LeConte

*Females:* 5/16/53. One specimen dissected. This had mature ovaries with developing eggs and well marked corpora lutea. No eggs present in the oviducts.

*Males:* 5/16/53. Three specimens dissected. One testis present in each. Testes full of mature sperm packets. Vasa full of sperm ribbons. Accessory glands full of opaque material.

This species is a spring breeder and probably an imaginal overwinterer. Blatchley's dates for adults (April 19–August 20), support this, and suggest that the new imago spend the winter in or near their pupal cells.

#### DISCUSSION

Most of the carabid beetles examined from Carlé Woods were spring breeders. This was to be expected as the collections were made in the spring. In a few instances, notably in *Enferonia*

*stygica*, judgment has had to be suspended. As the samples which were examined were small the conclusions reached can only be tentative. Further investigation may show that the broad division of breeding types noted in the Carabidae of western Europe does not apply similarly to the carabid fauna of mid-western U.S.A. In addition the proximity of Lake Michigan to Carlé Woods (ca. 12 miles) may be a complicating factor owing to the Lake's ameliorating effect on climate. There is evidence (Lindroth, 1949) that carabid species distributed over a wide climatic range can be larval overwinterers in the more temperate regions and imaginal overwinterers in the more severe.

My sincerest thanks are due to Professor Orlando Park for his interest and ready assistance in this work.

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#### ERRATA

In Vol. 33, No. 1, page 46, line 7 *Arconotus* should read *Arctonotus*. In line 10, June 15 should be January 15; *A. lucidus* is a winter species.